

The ambiregnal protists and the Codes of nomenclature: a brief review of the problem and of proposed solutions

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Abstract. Among the tens of thousands of species of protists recognized today, a goodly number are known as 'ambiregnal' because of their past treatment both as algae and as protozoa, which caused their names to fall under the jurisdiction of both the botanical and the zoological Codes of nomenclature. Now that many of them have been determined to be more closely related to one another than to members of the plant and animal kingdoms, a solution is needed to relieve their names of the highly undesirable situation of being subject to different treatment by different workers, as is possible under the existing Codes. Six proposed solutions of the complicated problem are examined, with one — harmonization of the relevant Codes — heralded as the most likely to meet the crying needs of the situation. In addition, a plea is made for recommendation in the Codes of guidelines useful in the cases of suprafamilial names of the many diverse high-level protistan assemblages.

The organisms widely known vernacularly as 'the protists' — roughly defined as including all of the protozoa, the eukaryotic algae, and the so-called 'lower fungi' (zoosporic and plasmodial species) — have become objects of intensive studies in recent years as they have been increasingly perceived not only as model cells but also as groups of great evolutionary significance in the origin of the 'higher' eukaryotes, the plants, animals, and fungi (for latest review, see Corliss, 1994a). While considerable attention has been paid to their ultrastructural, biochemical and molecular properties on the one hand, and to their phylogenetic interrelationships on the other, rather few biologists have expressed an interest in the nomenclatural problems arising from their high-level systematic separation from (most) plants and animals. That is, they can no longer be treated taxonomically as simply 'mini-plants' or 'mini-animals' (Corliss, 1983, 1986, 1994b).

Directly involved in their taxonomy and nomenclature, at the lower classification levels particularly, are the various Codes of nomenclature, which contain both mandatory and recommended provisions concerning family, generic and specific names of all living and fossil organisms. The two Codes of special concern to the topic under consideration are the *International Code of Botanical Nomenclature* (Greuter *et al.*, 1994) and the *International Code of Zoological Nomenclature* (International Commission on Zoological Nomenclature, 1985).

Because the great majority of species of protists are, by widespread general agreement, no longer formally assignable to the kingdoms of plants or animals, their nomenclature might be considered to fall under no existing Code. This would be an unacceptable vacuum. These microbial eukaryotes might be assigned to the jurisdiction of one or the other (or some combination of both) of the two major Codes named above, but this would create an almost equally unsatisfactory situation (see later sections of this paper). The problem is exacerbated by the fact that some 30,000

named species of protists, mostly single-celled, motile, microscopic forms with or without plastids, have been formally classified, simultaneously, as plants (algae or fungi) and as animals (protozoa). Thus, their nomenclature fell (or potentially fell) under two Codes at the same time.

The special category of 'lower' eukaryotes described immediately above has come to be known (adopting the apt term coined by Patterson, 1986) as the ambireginal protists. The principal groups involved are: all the euglenids *sensu lato*, dinoflagellates, cryptomonads, haptophytes, and glaucophytes; many 'chromophytes' (or heterokonts), particularly those whose flagella bear tripartite hairs; some 'proteromonads'; scattered species among the 'chlorophytes' or green algae (e.g., Volvocales *sensu lato* and prasinophytes); and numerous plasmodial forms (the so-called myxomycetes/mycetozoa *sensu lato*) plus the chytrids — groups claimed by both mycologists and zoologists (or protistologists).

How can we resolve the unsettled and unsettling nomenclatural problems caused by the protist situation and especially by the existence of the ambireginal forms, which involve some 15% or more of the estimated (Corliss, 1984) 200,000 species?

An understanding of the situation has to be the first step. Encouragingly, the very recent Report of an IUBS/IUMS committee on harmonization among Codes of nomenclature (Hawksworth *et al.*, 1994), published in this *Bulletin* (BZN 51: 188–216) and concurrently as a Special Issue (number 30) of *Biology International*, has provided a detailed, informative background. It stresses potential resolution of current Code differences that are impeding pragmatic progress with respect to some dozen major issues, ambireginal organisms prominent among them. That report (see also Hawksworth, 1991, 1992; Jeffrey, 1990; Ride, 1988; Ride & YOUNÈS, 1986) makes unnecessary my repetition of numerous facts. The interested reader is referred also to Corliss (1990, 1991, 1993) and Patterson & Larsen (1991, 1992) for recent papers approaching the problem solely from a protist perspective; they raise some aspects of the matter (see below) perhaps inadequately addressed by the Hawksworth committee.

Extent of the Overall Problem

It is not appreciated by many non-protistologically oriented biologists that the ambireginal problem extends to suprafamilial taxonomic levels, as well as involving the lower — currently Code-regulated — categories. That there are inevitably some areas of overlap in proposed solutions with respect to these two categories complicates the situation.

Too little attention has been paid to the effect of (the necessity of) abandoning the single 'kingdom Protista' concept for the more supportable multiple eukaryotic kingdom hypothesis in which protistan groups are distributed among at least six separate kingdoms (see Cavalier-Smith, 1993; Corliss, 1994a, and references therein), three of which may be composed solely of protists. Such distribution of diverse algal, fungal, and protozoan taxa amongst different kingdoms and phyla precludes their convenient treatment as a single top-level assemblage (and therefore completely eliminates the notion of a separate Code for protists: Corliss, 1993). The concomitant shifting of species also confounds any simple Code-regulated solution at the lower taxonomic levels, often with respect to non-ambireginal as well as ambireginal species.

Anxious to have answers to the problems addressed in this paper are not only the practising taxonomists and nomenclaturists of the world but also general biologists, textbook writers, teachers, bench investigators using whole organisms or their cells, ecologists and evolutionary biologists, students of conservation and biodiversity, and also information retrieval specialists and culture collection and type specimen collection managers.

Consideration of Specific Solutions

The strengths and weaknesses of full or partial solutions proposed in the past, and of resolutions currently under study, need to be considered here, albeit very briefly, mostly to alert the reader to progress being made. The recent increase of interest in the problems spelled out above is encouraging; and the outlook for successful resolution of most, if not all, of them is now more optimistic than it has been for years.

1. Arbitrary Assignment of (Higher) Taxa to a Given Code

With the tacit recognition of the demise of the single kingdom Protista to embrace all protists (see especially Cavalier-Smith, 1993; Corliss, 1994a,b, 1995; Patterson, 1994), it becomes clear that the notion of 'one Kingdom, one Code' is not a feasible one, as discussed in some detail by Corliss (1993). But it is also true that a proposal by Cavalier-Smith (1981, 1993) and others — that members of a given kingdom be arbitrarily assigned to a given Code for nomenclatural purposes — is unwise, especially in view of the current instability of protistan highest-level taxa and their precise ranks (and names). Nor would improvement be obtained by having some international body make the arbitrary assignment, another idea which has been mentioned in the literature.

Nevertheless, there is logic in Cavalier-Smith's defense of his assignments: he places his most 'animal-like' (heterotrophic nutrition, presence of locomotory organelles, lack of cell walls, etc.) kingdoms (*viz.* the Archezoa, Protozoa, and Animalia) under jurisdiction of the Zoological Code, and his most 'plant-like' ones (*viz.* the Chromista, Fungi, and Plantae) under the Botanical Code. Unfortunately, admitted exceptions involving hundreds of species exist in each case. While I consider his proposal not satisfactory, it does or would solve most of the problems outlined on preceding pages and is worthy of consideration or at least citation (neither of which it has received to date in the growing literature on this subject). In many instances, his solution coincides with current and past nomenclatural practices (see below) with regard to numerous — but not all — ambireginal species of protists; but these other solutions are, for the most part, also unsatisfactory.

2. Individual Author's Choice as to which Code to Use

Under this procedure, the individual taxonomist would simply choose to employ a particular Code. However, whatever he or she decided, the result would surely meet with opposition and disagreement by other specialists in the field (probably depending on their training, either as botanists or zoologists). Literature comparisons would be difficult and there would be confusion for retrieval systems. There is no way in which this idea can be considered as a proposal of much worth.

3. Publication of Both Nomenclatures for Ambiregna! Organisms

This procedure avoids the problem of upsetting most botanical or zoological users of a given taxonomic work. It has been favored by protistologists such as Patterson & Larsen (1991, 1992), who urge its adoption. But I consider it to be an unsatisfactory answer to the dilemma of ambiregna! (or other) protists because it really begs the question and postpones a solution. Also, requiring all investigators to be intimately familiar with traditional (and newer) systems of both botanical and zoological classifications for the microbial eukaryotes they may happen to be studying is patently unreasonable. Yet the proposal may be helpful in underscoring the problem confronting such workers, and it has already been put into operation by several conscientious groups (see, for example, Larsen & Patterson, 1990; Novarino & Lucas, 1993, 1995).

4. Piecemeal Repair of Codes on a Case-by-Case Basis

This has already been a policy of all commissions/committees involved in revising various of the Codes, and it is a laudable approach. Certain specific vexatious problems, or at least sub-problems, have been taken care of by such repair. Such solutions, however, represent only a 'first-aid' substitute for the major surgery required, and they are too cumbersome to take care of the major problems addressed here and in the report by the Hawksworth committee. Nevertheless, they might well be continued to advantage while international groups are debating methods by which more drastic revision may be made.

5. Establishment of a Single 'Ecumenical' Code of Nomenclature

Nearly the opposite of 'one Kingdom, one Code' is the idea of 'one Code, *all* Kingdoms', which would embrace even the prokaryotes and the viruses. This would appear to be a possible aim of the Hawksworth committee (Hawksworth *et al.*, 1994), although most of the emphasis in their enlightening report is on *harmonization* of the 'big five' existing Codes (which deal with plants, cultivated plants, bacteria, animals and viruses). While there are theoretical merits in a single Code for all contemporary and fossil life on Earth, many pragmatic reasons militate against its feasibility. Perhaps the greatest pitfall of all is the instant negative effect such a document would have on a multitude of nomenclatural decisions of past decades, even past centuries. Numerous changes in former names would inevitably be required in various groups, unless some very strong provision were included — a kind of 'grandfather clause' — which would exempt from change all the decisions made before a certain arbitrarily chosen date. Still, this would not solve many of our ambiregna! problems, such as homonyms, different starting dates and typification procedures, etc. And practising protist taxonomists would (once again!) be obliged to be familiar with relevant old Codes as well as the new one!

Amalgamation of all existing Codes into one does represent the utopian solution for the future unity of biological nomenclature; but surely it can be, at best, only a very long-range goal.

6. Relinquishing the (Nearly) Absolute Independence of the Codes

Put more positively, this can be rephrased as harmonization of the existing Codes, an excellent solution to the ambiregna! and other nomenclatural problems of such

concern to the taxonomic and general biological communities today. This is the topic to which the IUBS/IUMS 'exploratory meeting' addressed itself. In my view, finding ways of bringing the Codes into harmony with respect to the various controversial issues in need of solution does not necessarily mean that a single new Code must be the eventual result. Some time-honored provisions probably could be preserved without causing grave conflicts in their application; others could be protected by the 'grandfather clause' technique. Often, altered or entirely new Articles in the Codes (e.g., along the lines of proposals in Taylor *et al.*, 1986, 1987) could suffice to demonstrate a kind of joint jurisdiction over the nomenclature of taxa of protists. With respect to our ambireginal species, only the two major current eukaryotic Codes need to be so standardized.

Solving all of our problems by this approach will require a lot of time and co-operation and perhaps compromise, a good deal of dedicated work on the part of a number of people, and certainly considerable funding. Organizers of the present Codes have very limited fiscal resources available to them, a block that will need to be overcome.

7. Guidelines concerning the Names of Suprafamilial Taxa

Harmonization of existing Codes will do little to ease the problem, which particularly involves protists, of nomenclatural practice for names of the highest ranking taxa (orders up through at least kingdoms). Under the impact of molecular studies on the phylogenetics of organisms — and particularly if workers hold strictly to monophyletic principles — we may some day have nearly as many kingdoms as we have phyla today! Ultrastructural, biochemical and ribosomal-RNA sequencing studies are revealing that the protists show a far greater diversity — morphologically, physiologically and genetically — than all the rest of the eukaryotic groups put together (Andersen, 1992; Cavalier-Smith, 1993; Corliss, 1994a; Margulis *et al.*, 1990; Patterson, 1994; Schlegel, 1991). The number of kingdoms (six) of eukaryotes endorsed by me (e.g. in Corliss, 1994a) is a rather conservative one indeed.

Problems here include choices of the names for the high taxa mentioned above, dates of origins and authorships, handling of emended names, matters of prefixes and suffixes, priorities, rejections, nomenclatural effects of splits and consolidations or of changes in level/rank of taxa, etc.

Is there any way to avoid the 'undisciplined proliferation' of high-level names, a phenomenon so decried by Patterson & Larsen (1991)? The rash of name-giving to newly created suprafamilial taxa of protists, so prevalent in the 1970s and 1980s, was — particularly in hindsight — deplorable; and it certainly did not serve to endear nomenclatural taxonomists to the general biological community (Corliss, 1993). But it could happen again, if monophyletic lineages only partially identifiable with classical taxa are all given fresh labels in the shape of new formal names (Patterson, 1994).

Therefore, as I have been suggesting for a number of years (see earlier references in Corliss, 1993), future editions of the Codes should contain at least some *recommended guidelines* concerning nomenclature of suprafamilial taxa, not only of protists but of all organisms. Along with approved Lists of (names of) organisms (a proposal moving forward positively: see Hawksworth *et al.*, 1994), such an action would go a long way towards stabilization of nomenclature at levels not presently

covered by the Codes. As always, however, there must be no infringement upon the taxonomic freedom of the individual investigator.

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